GEOLOGY OF THE LITTLE PIGEON HOLLOW AREA SANPETE COUNTY, UTAH

by

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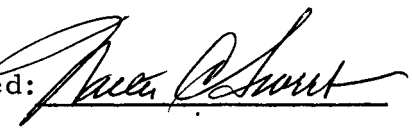
Approved: 

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INTRODUCTION

The Little Pigeon Hollow is an area of 16 square miles northwest of Ephraim, Utah, which is about 100 miles south of Salt Lake City. Ephraim is in Sanpete Valley, which is about 30 miles long and is bounded by the Gunnison Plateau on the west and the Wasatch Plateau on the east (Fig. 1). Ephraim and the area mapped as the Little Pigeon Hollow Area can be seen in Figure 2, which is a detailed map of the area blocked off in Figure 1. The Little Pigeon Hollow Area is on the Wasatch monocline on which strata dip west from the Wasatch Plateau toward Sanpete Valley.

Geologic field work is done every summer in Sanpete Valley where The Ohio State University has its field station. There has been much previous work in the Central Utah area. E. M. Spieker is certainly a name that stands out in the literature on Central Utah, and many others have studied the Sanpete Valley area.

Eight weeks, from June 17, 1968, to August 2, 1968, were spent in Ephraim and about four of those weeks were spent in the Little Pigeon Hollow Area. Marilyn Dreher, Fran Geib, and the writer used triangulation and air photos to map the geology of the Little Pigeon Hollow Area. Those assisting in the field were James Collinson, Walt Hasenmueller, Sidney White, Wayne Pettyjohn, and Richard Threet.

Acknowledgement must be made to Walter C. Sweet for his criticism, corrections, and help. Thanks are due to all of those assisting in the field work and to Dave Lichy who gave permission to use his measured section of

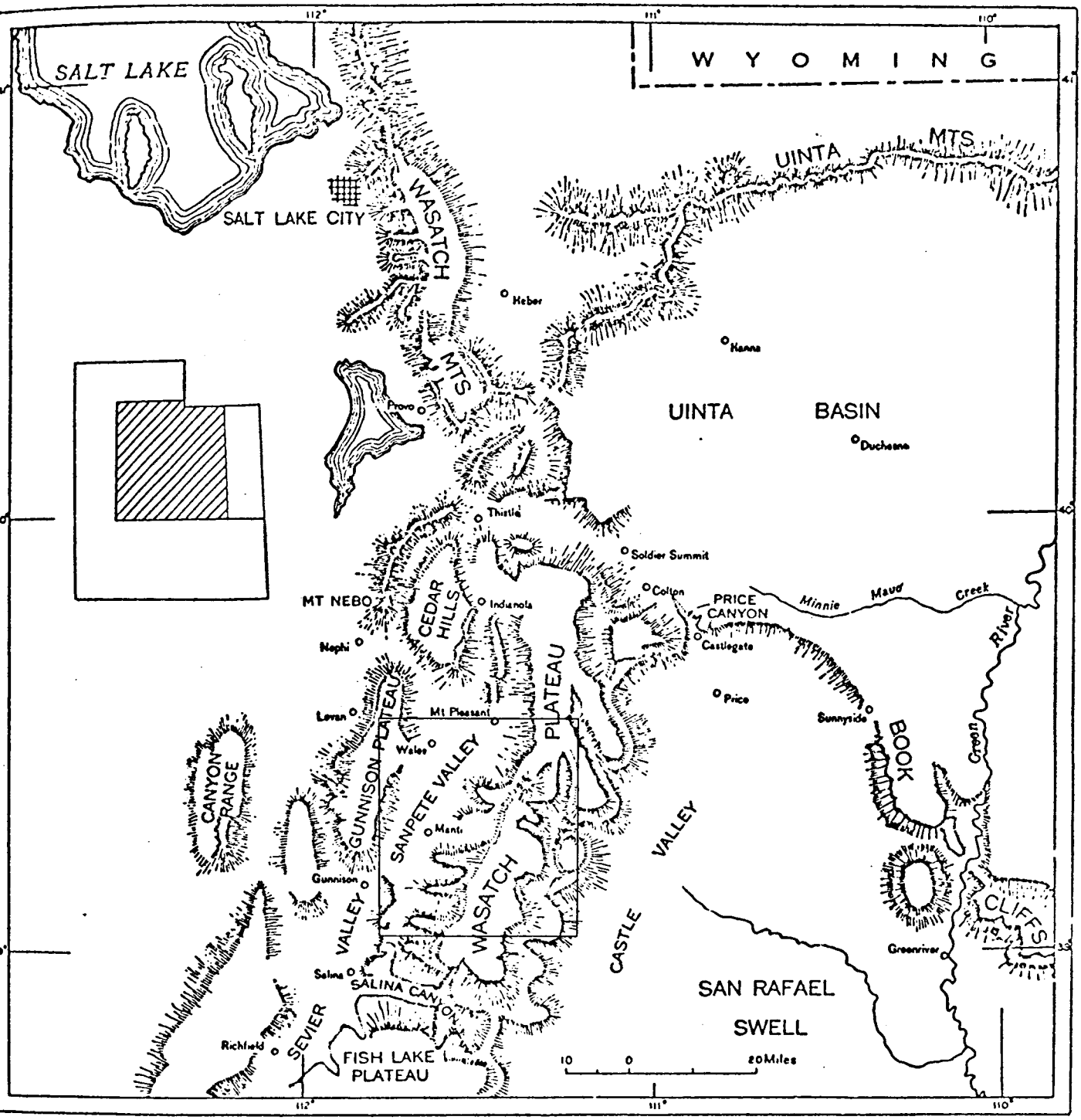

FIGURE 1. INDEX MAP OF PART OF UTAH SHOWING LOCATION OF FIGURE 2

(Modified after E. M. Spieker, 1946)

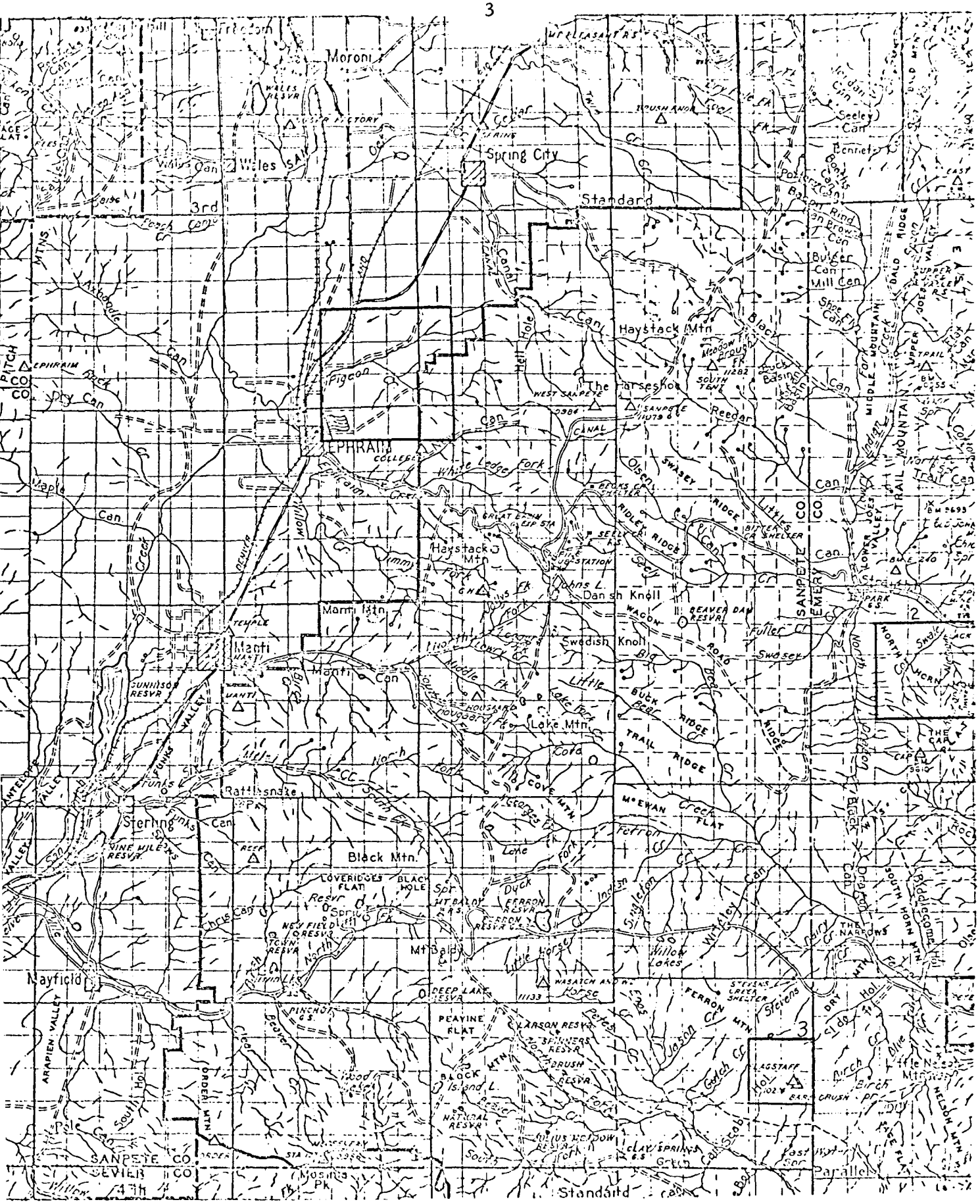

FIGURE 2. INDEX MAP OF PART OF UTAH SHOWING:
(1) The Little Pigeon Hollow Area;
(2) North Horn Mountain
(3) Flagstaff Peak

Colton. Special thanks are due to my wife, Paula, who typed the report, colored the map and had it drymounted; and to Fred Myers who did all the lettering on the map.

STRATIGRAPHY

General Statement

The bedrock of the Little Pigeon Hollow Area can be divided into five formations. The oldest, North Horn Formation, consists mainly of mudstone and sandstone with more limestone exposed near the top. The base of the North Horn Formation is not exposed in the area mapped. Overlying the North Horn is the Flagstaff Limestone, which consists of about 330 feet of alternating mudstone and limestone. Conformably overlying the Flagstaff is the Colton Formation, about 1590 feet of variegated mudstone that contains a few channel sandstones. These three formations were formerly classified as the Wasatch Formation of Central Utah (Spieker and Reeside, 1925). The Green River Formation overlies the Colton and about 530 feet of light green limestone and mudstone are exposed. The Crazy Hollow, which is the youngest formation in the area mapped, lies disconformably on the Green River. All these formations record deposition in a fluviatile and lacustrine environment.

Cretaceous and Tertiary Systems

North Horn Formation

Rocks now included in the North Horn Formation were once described by Spieker (Spieker, E. M., and Reeside, J. B., Jr., 1925, p. 448) as the lower member of the Wasatch Formation of Central Utah. The type

locality is North Horn Mountain in Ts.18 and 19S., R. 6E. Salt Lake meridian. Spieker divides the North Horn Formation at its type locality into four main units that represent an alternation between lacustrine and fluvial deposition.

The North Horn Formation in the Little Pigeon Hollow Area was measured and described along Pigeon Creek, in a section that begins at the eastern edge of Sec. 31. The 500 feet of rock exposed can be divided into three main units. The lowest unit is 100 feet of variegated mudstone with beds of sandstone that range from 2 to 12 feet in thickness. Also, there is a thin bed of oncolites near the base of this unit. The middle unit consists of 100 feet of yellow and brown mudstones, which have an overall color of pink. Sandstone beds in the lower two units are very different from one another. Some are poorly sorted and others are well sorted. The degree of roundness varies; even in the same bed there are subangular to subrounded grains of quartz. The upper unit is 300 feet thick and consists mostly of interbedded mudstone and limestone. There are lithographic limestones with calcite veins, and fossiliferous limestone. Toward the top of the unit there are alternating beds of mudstone, limestone, and sandstone. The top 20 feet of the North Horn is a bed of sandstone that grades upward from silt-sized particles to coarse grains.

The base of the North Horn Formation is not exposed in the Little Pigeon Hollow Area. Only the upper 500 feet is exposed in a wedge-shaped area on the Wasatch monocline along Pigeon Creek. The contact with the Flagstaff Limestone is gradational. All of the formations exposed along Pigeon Creek are conformable.

Fossils collected in 1935 by J. B. Reeside, Jr., and E. M. Spieker and identified by C. W. Gilmore indicated the age of the lower North Horn is Cretaceous. However, a poorly preserved fragment of a small mammal skull was characterized by C. L. Gasin and G. G. Simpson as generically unidentifiable but in their opinion not Cretaceous in age. Therefore, Spieker said that the passage from Cretaceous to Tertiary lies somewhere within the North Horn formation (Spieker, 1946).

Tertiary System

Flagstaff Limestone

The rocks here described as the Flagstaff Limestone were originally the Flagstaff member of the Wasatch Formation of Central Utah (Spieker, and Reeside, J. B., Jr., 1925). The unit was raised to formational status by Spieker in 1946. The unit was not originally defined as a formation because it was considered to be a lacustrine phase between floodplain deposits of Wasatch age (Spieker, 1946). The type locality is on the slopes of Flagstaff Peak, T. 20S., R. 5E., Sanpete County, Utah.

In the Little Pigeon Hollow Area, the Flagstaff Limestone consists almost entirely of alternating beds of limestone and mudstone. However, there are several beds of sandstone, which are either fine or medium grained and well sorted. The limestone exposed along Pigeon Creek has a massive appearance. However, close examination of a bed shows that the massive limestone alternates between fossiliferous and cherty limestone.

The upper 160 feet of the Flagstaff Limestone consists mainly of alternating beds of mudstone, shale and laminated limestone with cherty and fossiliferous limestones found in float. Overall, the limestone in the lower Flagstaff is more massive and ledge-forming than the limestone in the upper Flagstaff.

The total thickness of Flagstaff Limestone exposed along Pigeon Creek is 330 feet. Areally, distribution of the Flagstaff exposure parallels the front of the Wasatch monocline. The formation is conformable with both the overlying Colton and the underlying North Horn Formations. The contact between the Flagstaff Limestone and the North Horn Formation was placed at the level of change from the dominant sandstone of the North Horn to the dominant limestone of the Flagstaff. Similarly, the level of change from limestone to variegated mudstone and sandstone marked the base of the Colton Formation.

The 800 feet of Flagstaff, exposed and measured at Ephraim Canyon (sec. n½ sec. 13, T. 17S., R. 3E) by Mike Morgan, Dave Lichy and Tom Wheeler contradicts the 330 feet exposed at Pigeon Creek, This difference in thickness can be attributed to the intertongueing relationship between the Flagstaff and North Horn Formations (Spieker, 1946). The section of Flagstaff measured at Pigeon Creek may have been only a tongue of the Flagstaff.

There is no evidence at the level of contact of the Flagstaff and North Horn of a noticeable time break. On the basis of study of molluscan fauna (La Rocque, 1960), the age of the Flagstaff formations is regarded as late Paliocene and early Eocene.

Colton Formation

The rocks now included in the Colton Formation were once described by Spieker and Reeside (1925) as the upper member of the Wasatch Formation of Central Utah. The name Colton Formation was applied to these strata by Spieker (1946). The type locality of the Colton Formation is two miles east of Colton, Utah, at the head of Price Canyon.

The stratigraphic section of the Colton Formation described in this paper was measured and described by Mr. Dave Lichy about two miles south of the Little Pigeon Hollow Area. In that section, the Colton formation consists of variegated mudstone, thin beds of massive limestone and thick massive units of channel sandstone. The mudstone, which is certainly the dominant rock of the Colton, alternates from red to gray and green. The limestone is almost everywhere gray and massive. Several varieties noted were lithographic, argillaceous, and crystalline. Almost all of the sandstone described in Lichy's measured section is brown or light brown, friable, and massive.

The total Colton thickness measured by Lichy was 1590 feet. In the Little Pigeon Hollow Area, the Colton Formation crops out in a band along the front of the Wasatch monocline just west of the area of Flagstaff exposure. The Colton overlies the Flagstaff Limestone conformably. The contact between the Flagstaff and the Colton was placed at the level of change from the dominant limestone of the Flagstaff to the variegated mudstone of the Colton.

Since the Colton beds contain mollusks that are members of the early Eocene Wasatch fauna (Spieker, 1946, p. 135), it appears that the Colton

Formation can be dated as early Eocene. Also, it is probable that the age of the Colton Formation is early Eocene because of stratigraphic criteria. That is, the formation is above the Flagstaff, which may be Paleocene or very early Eocene in age, and it is below the Green River Formation, which is probably lower or middle Eocene in age.

The Colton was assigned to the early Eocene by Spieker (1949). La Rocque (1960), on the basis of his studies of the molluscan fauna, agrees with this early Eocene assignment to the Colton formation.

Green River Formation

The type locality of the Green River Formation is at the town of Green River, Sweetwater County, Wyoming. It was named by Hayden (1869, p. 90) for the exposures at Green River.

In the Little Pigeon Hollow Area, the Green River Formation can be divided into two main units. The lower unit consists dominantly of mudstone at its base and limestone at the top. Although most of the slope exposed at White and Black Hill is well-weathered mudstone, there are beds of sandstone, tuff, and limestone within it. The sandstone is massive with fine- to medium-sized grains of quartz and biotite. The ryolite tuff is yellowish-brown and has euhedral hexagonal crystals of biotite. The limestones above the tuff beds are massive and contain numerous ostracodes. The top of this main unit is dominantly a massive limestone, which is white to light green and oölitic. The upper unit consists mostly of alternating beds of mudstone and shale, and limestone.

It is similar in appearance to the well-weathered mudstone slope at the base of the lower unit.

The Green River of the Little Pigeon Hollow Area crops out in the cuestas at the west edge of the Wasatch monocline. The exposed thickness of the Green River, measured at White Hill, is 537 feet. At the base of White Hill, the Colton Formation lies conformably below the Green River. However, Spieker (1946) says that the Colton and the Green River Formations intertongue. This means that the two formations are equal in age at some parts. The Crazy Hollow Formation lies unconformably on the Green River.

On the basis of Early Eocene mollusks found in the Colton Formation (La Rocque, 1956, p. 140) and ostracodes identified by Swain (1949, p. 175; 1956, p. 135) the age of the Green River Formation is probably early or middle Eocene.

Crazy Hollow Formation

The type locality of the Crazy Hollow Formation is in Crazy Hollow (secs. 5 and 8, T. 22S., R. 1E., Utah), a short gulch west of the mouth of Soldier Canyon. In the Little Pigeon Hollow Area, the basal Crazy Hollow Formation is a coarse-grained, friable sandstone. The sandstone, which has a salt-and-pepper appearance due to the quartz and black chert, is cross-bedded and has numerous lenses of well-rounded pebbles. The upper unit of the Crazy Hollow in the Little Pigeon Hollow Area is exposed at Sand Ridge. There the yellowish-brown sandstone consists of grains that

are finer than in the lower portion. Most of Sand Ridge consists of slope-like material because the sandstone weathers easily. There are only a few beds that have resisted the weathering.

In the Little Pigeon Hollow Area the total thickness of the Crazy Hollow is 185 feet. The lower unit, which consists of coarse grains, is 60 feet thick. The upper unit, which consists of finer grains than the lower unit, is 125 feet thick. Areally, the Crazy Hollow exposure is west of the Green River cuestas. However, these outcrops are not continuous; that is, the Crazy Hollow does not completely cover the slope of the cuestas. This is because the Crazy Hollow lies unconformably on the Green River.

The age of the Crazy Hollow Formation is not known. No fossils have so far been found and an estimate of its age can be based only on stratigraphic relations with those formations above and below. On the basis of this, the age is estimated as late Eocene (Spieker, 1946).

STRUCTURAL GEOLOGY

The Little Pigeon Hollow Area, at the west edge of Sanpete Valley, is structurally within the western part of the Wasatch monocline. Immediately west of the Little Pigeon Hollow Area is Sanpete Valley, a structural depression filled with alluvium.

In the southwestern part of the area mapped (sec. 1, T. 17S., R. 3E.; sec. 6, T. 17S., R. 4E.; secs. 30 and 31, T. 16S., R. 4E.; and SE¼, sec. 36, T. 16S., R. 3E.), the Wasatch monocline strikes about N 34°E, dips from about 23° to 38° W, and is expressed in strata of the North Horn, Flagstaff, and Colton Formations. Beds exposed in the Green River cuestas (secs. 23, 24, 35, and W½ 36, T. 16S., R. 3E.), however, strike about N10°E and dip about 7°W. This disparity in strike poses the most perplexing structural problem in the Little Pigeon Hollow Area. A more detailed consideration of structure in the Green River cuestas may offer answers to this problem.

Considering only White Hill (secs. 23 and 24), the outcrop of Crazy Hollow is surrounded by Green River, which makes up most of the cuesta. In structural geology textbooks, this outcrop pattern suggests a synclinal structure, where the younger beds are inside and the older beds outside. However, there is no other support for this syncline because of lack of strike and dip of the Crazy Hollow and Green River beds. Considering only Black Hill (secs. 35 and 36), the Crazy Hollow crops out in a vague V-shaped pattern, which starts in the southern part of section 27, continues to section 36 at the point of the V, and crops out again in the eastern part of section 34.

This again suggests a syncline plunging westward into Sanpete Valley. However, again lack of strike and dip prevents complete support of a syncline.

If there are two synclines, an anticline would be along a line from the centers of sections 25 and 26, which is the center of Little Pigeon Hollow. Perhaps this is the reason for the hollows. If one can imagine a gently plunging anticline in the area of Little Pigeon Hollow (sec. 25), the bedrock, which would be at the same elevation as the cuestas, would probably be the weak mudstone of the Colton; thus allowing the hollows to form because the mudstone erodes relatively faster than the massive limestone exposed in the Green River cuestas.

Another interesting item is that the landslides (north half of sec. 30, T. 16S., R. 4E., and sec. 1, T. 17S., R. 3E.) in the Little Pigeon Hollow Area are directly east of the two hollows (Little Pigeon Hollow in sec. 25 and Cane Valley in sec. 2, T. 17S., R. 3E.). This suggests that the landslides may be associated with the anticlines (if they exist).

At Pigeon Creek (west edge at sec. 31, T. 16S., R. 4E.), Colton beds dip about 38° NW. At the next valley south of Pigeon Creek (southeastern edge of sec. 36, T. 16S., R. 3E.), Colton beds dip as much as 50° NW; and in the valley north of the landslide debris (NE¼, sec. 1, T. 17S., R. 3E.), Colton beds dip at various angles, including overturned and dipping toward the east. South of the landslide debris (SW¼, sec. 1, T. 17S., R. 3 E.), Colton beds resume a dip of 50° NW. If there is an anticline and if the landslide is associated with it, it seems very probable that there would be a

gradual change in strike as well as dip of the Colton beds on either side of the landslide. However, lack of good control in this area prevents the conclusion of an anticline near the landslide debris.

If the Crazy Hollow and Green River beds exposed in the cuestas are crumpled -- that is, if the synclines and anticlines exist, they must have been formed by a compressive force. It is very possible that the compressive force may have created the disparity in strike between the Green River beds exposed in the cuestas, and the beds of the Colton, Flagstaff, and North Horn Formations, exposed in the southeastern part of the map.

A major fault, striking N 10° E and dipping 80° W is exposed along the eastern edge of the Little Pigeon Hollow Area (SE¼, sec. 30 and sec. 31, T. 16S., R. 4E.; sec. 6, T. 17S, R. 4E.). The east side is down relative to the west, hence displacement on this fault is opposed to the regional trend of folding. Therefore, this fault is an antithetic fault. The total displacement of the fault, which is 300 feet, was measured at the north wall of New Canyon (sec. 7, T. 17S., R. 4E.) by Mike Morgan and Dave Lichy. The offset of the North Horn by the fault, if there is any, is not shown on the map (SE¼ sec. 31, T. 16S., R. 4E.) because the fault was not seen here but only estimated. Other faults in the Little Pigeon Hollow Area are exposed at the top of White Hill (sec. 24, T. 16S., R. 3E.). The displacement of one fault, measured at the tuff bed, is 8 feet, and the displacement of another fault, about 50 feet from it, is 6 feet. In all of the minor faults exposed here, the south side is up relative to the north. The only unconformity in the Little Pigeon Hollow Area occurs between the Green River and the Crazy Hollow where the Crazy Hollow lies disconformably on the Green River.

GEOLOGIC HISTORY

Geologic history that can be reconstructed from rocks and structures now exposed in the Little Pigeon Hollow Area begins in the late Cretaceous with deposition of the North Horn Formation. That part of the North Horn exposed in the Little Pigeon Hollow Area was probably deposited in a fluviatile environment. This is based upon poor sorting, and varying degrees of roundness of the sandstone beds, and also the overall colors of purple and pink of the formation.

The Flagstaff Limestone, deposited on top of the North Horn Formation during the late Paleocene and early Eocene, records a lacustrine depositional environment. Some of the limestone beds contain freshwater gastropods and pelicypods (Spieker, 1946), and these distinguish the limestone beds from marine limestones.

The lacustrine environment indicated by the Flagstaff was interrupted in early Eocene by fluvial deposits of the Colton Formation. The many channel sandstones are evidence that the Colton was deposited in a fluviatile environment. These massive channel sandstones alternate with mudstone and thin beds of limestone containing freshwater mollusks.

After deposition of the Colton, the Green River Formation was deposited in another lake formed in early or middle Eocene times. The dominant rock of the Green River, mudstone and limestone with non-marine ostracodes (Swain, 1949), indicates a lacustrine environment.

Following the deposition of the Green River and before the deposition of the Crazy Hollow, part of the Green River was eroded and the fluviatile

Crazy Hollow lies disconformably on the Green River. Evidence for fluviatile deposition of the Crazy Hollow in the Little Pigeon Hollow area is cross-bedding, lenses of conglomerate pebbles, and the yellowish-brown color of the sandstone of the Crazy Hollow.

Sometime after the deposition of the Crazy Hollow Formation, the Wasatch Plateau was uplifted and its western margin was folded to form the Wasatch monocline. The two landslides probably occurred after the Wasatch Plateau was uplifted. Erosion of the Wasatch Plateau and Wasatch monocline and deposition in the valleys form the Quaternary colluvium and alluvium.

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